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Acanoides gen. n., a new spider genus from China with a note on the taxonomic status of *Acanthoneta* Eskov & Marusik, 1992 (Araneae, Linyphiidae, Micronetinae)

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Abstract

A new "micronetine" genus *Acanoides* **gen. n.** is erected to accommodate two species from China: *Acanoides beijingensis* **sp. n.** as the type species and *Acanoides hengshanensis* (Chen & Yin, 2000), **comb. n.**, with the females described for the first time. The genitalic characters and somatic features of the new genus were studied by means of light microscopy and scanning electron microscopy (SEM). The monophyly of the new genus was tested by a phylogenetic analysis based on molecular data. Descriptions of the new genus, the new species and the new combination are presented; SEM images and microscopy pictures of somatic and genitalic characters are provided in detail. To distinguish from other genera with similar genitalic characters, we compare the new genus with the species of *Acanthoneta* Eskov & Marusik, 1992, *Epibellowia* Tanasevitch, 1996 and *Wubanoides* Eskov, 1986. Four putative synapomorphies for *Acanoides* **gen. n.** are suggested to support its monophyly that could be tested in the future. Furthermore, redescriptions of the epigynal morphology of *Acanthoneta aggressa* Chamberlin & Ivie, 1943 (Nearctic) and on the male of *A. dokutchaevi* Eskov & Marusik, 1993 (Far East Asia, firstly recorded from China) are provided. Based on comparison with *Poeciloneta*, from which *Acanthoneta* **stat. n.** was separated by Saaristo and Tanasevitch (1996), a revised diagnosis is proposed to support the generic status.

Keywords
Taxonomy, new species, new genus, genitalic morphology, movable epigynum

Introduction

Micronetinae Hull, 1920 is a fairly large subfamily of Linyphiidae Blackwall, 1859, including 1199 species placed in 90 genera (Tanasevitch 2014). It was redelimited by Saaristo and Tanasevitch (1996), who established eight new genera for 89 species, and raised three subgenera to generic status. Subsequently, a series of revisions were published (e.g. Saaristo and Tanasevitch 2002a, 2002b; Saaristo and Marusik 2004; Saaristo et al. 2006; Tu et al. 2006; Tu and Li 2006) that resulted in many new genera and a new subfamily Ipainae Saaristo, 2007. Results of these series of review works have not been tested in a phylogenetic context; neither Micronetinae nor Ipainae monophyly, as well as that of the genera included in the two subfamilies have been tested so far.

Poeciloneta hengshanensis (Chen & Yin, 2000) from China, originally placed in *Lepthyphantes* Menge, 1866, has its male palp very similar to that of *Poeciloneta* (*Acanthoneta*) *aggressa* (Chamberlin & Ivie, 1943). *Acanthoneta* Eskov & Marusik, 1992 is one of the three genera raised from subgeneric status by Saaristo and Tanasevitch (1996) with the type species *Acanthoneta aggressa*. Tu et al. (2006) transferred *P. hengshanensis* to *Acanthoneta* based on the similarity of the male palpal morphology. However, raising *Acanthoneta* to a generic status "was not accompanied by a diagnosis or justification", and hence not accepted in The World Spider Catalog (Platnick 2014). All members of *Acanthoneta* are currently placed in *Poeciloneta* Kulczyński, 1894.

Females of *P. hengshanensis* (previously unknown) were found in new material from China. However, its epigynal conformation is neither congruent with that of *P. aggressa*, nor with any other species of *Poeciloneta*. Based on the presence of an extensible basal part, the movable epigynum accords with the diagnosis of the subfamily Ipainae Saaristo, 2007 (for example *Ipa* Saaristo, 2007 and *Solenysa* Simon, 1894). Additionally, we found another new species with genitalic morphology very similar to that of *P. hengshanensis*: the male palpal morphology similar to *Acanthoneta* and a movable epigynum in accordance with ipaine type.

A new genus *Acanoides* gen. n. is erected here for these two species. To test the placement of the new genus within Linyphiidae, a phylogenetic analysis based on newly sequenced molecular data of the two species and that of other linyphiids downloaded from NCBI was conducted. In the present study, the two species and the new genus are described. Characters of copulatory organs and somatic features of both species are illustrated by means of SEM and light microscopy. To distinguish the new genus from other "micronetine" genera with similar male palpal morphology and ipaine genera with a similar movable epigynum, the new genus is compared with the genera *Acanthoneta* (Micronetinae), *Wubanoides* Eskov, 1986 and *Epibellowia* Tanasevitch, 1996 (Ipainae). Due to limited material available for examination, comparisons are largely based on descrip-

tions and illustrations provided by Tanasevitch (1996), Saaristo and Tanasevitch (2000) and Saaristo (2007); images of the epigynum of *Acanthoneta aggressa* and the male of *A. dokutchaevi* Eskov and Marusik, 1994 are presented here. Four putative synapomorphies are suggested for *Acanoides* gen. n. that could be tested in future study. In addition, diagnoses for *Acanthoneta* stat. n. are provided based on comparison with illustrations of genitalic characters provided by Saaristo and Tanasevitch (2000), to support its generic status proposed by Saaristo and Tanasevitch (1996). The composition and monophyly of both *Acanoides* gen. n. and *Acanthoneta* stat. n. could be tested in future study.

Materials and methods

Specimens were examined and measured using a Leica M205A stereomicroscope. Male palps and epigyna were examined after they were dissected from the body. Left structures (e.g. palps, legs, etc.) were depicted. Embolic divisions were excised by breaking the membranous column which connects the suprategulum and radix. Male palps and epigyna were cleared in methyl salicylate. Digital images were taken with a Leica DFC 500 camera, as composites of multiple focus images assembled using the software package LEICA APPLICATION SUITE. Scanning electron microscopy (SEM) images were taken using a S-3400N scanning electron microscope at the China Agricultural University. For SEM examination the specimens were prepared following Álvarez-Padilla and Hormiga (2008). SEM images of the embolic division taken from the right palp were mirrored to match those taken from the left palp. All measurements were taken with a micrometer and are expressed in millimeters. The leg measurements are given in the following sequence: total (femur, patella+tibia, metatarsus, tarsus). All specimens examined here are deposited in the College of Life Sciences, Capital Normal University, China (CNU) and in the College of Life Sciences, Hunan Normal University, China (HNU), except for the female material of *A. aggressa*, the epigynal pictures of which were provided by Don Buckle (Saskatoon, Canada). Distribution data for these species within China are presented at the provincial level. Terminology for the epigynal characters follows Tu and Hormiga (2010) and male palpal and somatic characters follows that of Saaristo and Tanasevitch (1996) and Hormiga (2000). Anatomical abbreviations used in the text and figures:

Somatic morphology

AER anterior eye row
ALE anterior lateral eye(s)
AME anterior median eye(s)
AMEd diameter of AME
PER posterior eye row
PLE posterior lateral eye(s)

Male palp

AX	apex of embolus
DM	distal membrane of terminal apophysis
DSA	distal suprategular apophysis
EM	embolic membrane
EP	embolus proper
FiG	Fickert's gland
LC	lamella characteristica
P	paracymbium
PCA	proximal cymbial apophysis
PH	pit hook
R	radix
SE	serrated area on embolus
SPT	suprategulum
TA	terminal apophysis
TH	thumb of embolus

Epigynum

CO	copulatory opening
CG	copulatory groove
DP	dorsal plate
EA	extensible area of epigynal basal part
EB	epigynal basal part
FG	fertilization groove
MP	median plate
S	spermathecae
SC	scape
ST	stretcher
VP	ventral plate

Phylogenetic analysis

Based on the dataset of Arnedo et al. (2009) which includes 34 linyphiid taxa (*Erigone dentipalpis* was not included as it has only one of the five genes available), newly sequenced data of the two *Acanoides* and data of another 65 linyphiid taxa downloaded from NCBI were added. A total of 111 taxa were sampled in our matrix, ten outgroup taxa of other araneoid families as in that of Arnedo et al. (2009) and 101 ingroup taxa, which cover the representatives of all the seven subfamilies currently proposed; one *Solenysa*, as a representative of ipaine, and *Acanthoneta* were included to test the placement of *Acanoides*.

Five genes: cytochrome c oxidase subunit I (CO1) and 16S rRNA (16S) and three nuclear genes 18S rRNA (18S), 28S rRNA (28S) and Histone H3 (H3) were sequenced for *Acanoides beijingensis* sp. n. and *A. hengshanensis*. Molecular procedures for sequencing follow that of Arnedo et al. (2009), with the same molecular markers to maximize the overlap of dataset. Taxa sampled and sequence accession numbers are presented in Appendix - Table S1. Data were automatic multiple aligned using the computer program Clustal X version 1.81 (Thompson et al. 1997). Gaps were treated as missing data. Maximum Likelihood analysis was performed using RAxML v7.2.7 as implemented on the Cipres Gateway (Miller et al. 2010). Bootstrap support analysis was performed with the commands: raxmlHPC-HYBRID-7.3.1 -T 6 -s infile -n result -x 12345 -p 876 -f a -N 1000 -m GTRCAT -q part.

Results

All five genes were sequenced for *Acanoides beijingensis* sp. n. and *A. hengshanensis* (Appendix - Table S1). The monophyly of Linyphiidae and its sister relationship with Pimoidae were not recovered in the result of phylogenetic analysis as two outgroup taxa: cyatholipid *Alaranea* and theridiosomatid *Theridiosoma* are embedded within Linyphiidae (Appendix - Fig. S1). Besides some weakly supported deeper branches, four robustly supported clades are recognized: *Stemonyphantes* clade (clade S), "micronetines-erigonines" clade (clade ME), "linyphiines"-1 clade (clade L1) and "linyphiines"-2 (clade L2). For the seven subfamilies currently proposed, only Stemonyphantinae Wunderlich, 1986 (the *Stemonyphantes* clade) and Mynogleninae Lehtinen, 1967 are monophyletic, while the mynoglenines clade and the *Dubiaranea* clade fall into clades L1 and L2 respectively that make Linyphiinae Blackwall, 1859 become a paraphyletic group; taxa of Micronetinae form a paraphyletic group, nested with taxa of Ipainae and Erigoninae within clade ME. The two *Acanoides* species form a robustly supported monophyly, distantly related to *Acanthoneta* and *Solenysa*.

Discussion

The result of the phylogenetic analysis based on molecular data suggests that the new species from Beijing is the sister taxon of *P. hengshanensis* which had ever been transferred to *Acanthoneta* by Tu et al. (2006). The lineage comprised by the two species is distantly related to *Acanthoneta* sp. (Appendix - Fig. S1). Accordingly, we erected here *Acanoides* gen. n. to accommodate the two species: *A. beijingensis* sp. n. and *A. hengshanensis* comb. n. The three known *Acanthoneta* species have very distinct male palpal morphology, only differ from that of the type species in small details (Eskov and Marusik 1992, 1993). Regardless the *Acanthoneta* taxon is congeneric with, or is the type species *Acanthoneta aggresus*, the new genus differs from all the three known species of *Acanthoneta* as well as all other "micronetines" in the females having a movable

epigynum (Figs 4G, 5G) and the males having a longer and sharper embolus proper (Figs 2D, 3D) which generally is pointed in "micronetines" (Fig. 6F); Fickert's gland located in the membranous area outside the radix (Figs 2D, 3D), rather than embedded within the radix as usually the case in "micronetines" (Fig. 6G). This suggests that the two species are not congeneric with *Acanthoneta*.

Our results suggest an unknown *Lepthyphantes* species as a sister group to the *Acanoides* clade. *Lepthyphantes* Menge, 1866, which includes almost 500 species, is not a natural group (Saaristo and Tanasevitch 1996). All *Lepthyphantes* species, except five, have been transferred or are waiting to be transferred to other genera (e.g. Saaristo and Tanasevitch 1996, 2002a, b; Saaristo and Marusik 2004; Tu et al. 2006). The position of *Lepthyphantes* sp. on the tree indicates it is neither *Acanthoneta*, nor *Lepthyphantes*. Nevertheless, without morphological data, we fail to determine whether *Lepthyphantes* sp. is as a sister group of, or a number of *Acanoides* gen. n., so the close relative of *Acanoides* remains unresolved.

The genitalic characters of *Acanoides* make its subfamily placement problematic due to the epigynal character in accordance with Ipainae type, but the male palpal morphology of the "micronetine" type. Redelimitation of Mironetinae (Saaristo and Tanasevitch 1996) and the series of revisions of "micronetine" genera (e.g. Saaristo and Tanasevitch 2002a, 2002b; Saaristo and Marusik 2004; Saaristo et al. 2006; Tu et al. 2006; Tu and Li 2006) resulted in many new genera and even a new subfamily Ipainae (Saaristo 2007). However, none of them has been tested in a phylogenetic framework. Results of the first phylogenetic analysis for linyphiids based on molecular data indicate that neither Micronetinae nor Ipainae is a monophyletic group (Arnedo et al. 2009). Such a result was recovered in the present study too: "micronetine" taxa formed a paraphyletic group, and movable epigynum independently evolved in *Acanoides* and *Solenysa* (Appendix - Fig. S1). The extensible solenoid serving as a synapomorphy for *Solenysa* (Tu & Hormiga, 2011), the ventrally folded extensible epigynal basal part, together with long and sharp embolus proper, slender and unbranched lamella characteristica, and outside radix located Fickert's gland are four putative synapomorphies for *Acanoides* gen. n.

With greatly increased ingroup sampling, the result of the present study produce a similar topology with that of Arnedo et al. (2009): four strongly supported clades S, L1, L2 and ME that correspond to the *Stemonyphantes* clade, clades C and D, and the "micronetines-erigonines" clade in the latter (Appendix - Fig. S1). Most newly added taxa fell into the clade ME that enriched the topology. However, the problems left by the previous study (Arnedo et al. 2009), such as the monophyly of Linyphiidae, placements of the weakly supported deeper branches, and taxa of different subfamilies placed together rendering most of the traditionally recognized subfamilies non monophyletic, persist. Six of the seven subfamilies currently proposed are not monophyletic groups. The higher level relationships within linyphiids reflected by phylogenetic result are still far away from the classic subfamily system (see Millidge 1984, 1993; Saaristo and Tanasevitch 1996; Saaristo 2007). Nevertheless, revising the whole higher level linyphiid systematics is beyond the scope of the present study. In the text bellow we keep using Micronetinae and Ipainae following the current taxonomic system.

Although with ingroup sampling about two times increased, the sampling size of the current dataset seems not to be enough to resolve the placements of *Acanoides* and *Acanthoneta*, as well as *Poeciloneta*, from which *Acanthoneta* were separated (Eskov and Marusik 1992), their close relatives, and the relationships among them. To better understand the higher level phylogenetic relationships of linyphiid spiders, more information, such as morphology and behavior, and a comprehensive sampling design are necessary. Here, we provide four putative synapomorphies for the new genus *Acanoides* that could be tested in future phylogenetic studies.

Taxonomy

Linyphiidae Blackwall, 1859

Acanoides gen. n.

http://zoobank.org/4632240B-5228-4EB7-A1BC-CBD9176FEC2B
http://species-id.net/wiki/Acanoides

Type species. *Acanoides beijingensis* sp. n.

Composition. Two species, *Acanoides beijingensis* sp. n. and *Acanoides hengshanensis* (Chen & Yin, 2000) comb. n.

Diagnosis. The males of *Acanoides* gen. n. can be distinct from *Acanthoneta* by the sharp embolus proper, the slender lamella characteristica unbranched, and by the Fickert's gland located in the membranous area outside the radix (Figs 2D, 3D). The females can be distinguished by the ventrally folded extensible epigynal basal part (Figs 2F, 3F).

Description. Male total length 2.34–2.73; female total length 2.10–2.42. Carapace yellowish-brown. Male carapace unmodified. AMEs smallest, others subequal; from the dorsal view AER recurved, PER straight, eyes separated by AMEd, ALE and PLE juxtaposed. Chelicerae medium-sized, with strong stridulatory ridges, female fang groove with three promarginal and three retromarginal teeth in *A. beijingensis* sp. n., and two promarginal and two retromarginal teeth in *A. hengshanensis*. Chaetotaxy: Ti I–IV: 2-2-2-2; Mt I–IV: 1-1-1-1; Mt I of males with two rows of ventral bristles, one prolateral, one retrolateral (Fig. 1C, 1D); Tm I about 0.25, Tm IV absent. Both species have a haplotracheate system.

Male palp (Figs 2A–E, 3A–E, 4A–B, 5A–B). Cymbium with proximal apophysis. Paracymbium medium to large-sized, with one tooth on lateral margin. Distal suprategular apophysis not modified as pit hook, or absent. Embolic division: radix long and narrow, Fickert's gland located in the membranous area connecting radix and embolus; embolus wide and strongly sclerotized with serrated area, embolus proper sharp with a thumb and an apex at each side; lamella characteristica unbranched, long and narrow with sharp sclerotized apex, almost parallel to radix; terminal apophysis with distal membrane.

Epigynum (Figs 2F–H, 3F–G, 4G–H, 5G–H). Protruding, with deeply wrinkled basal part, extensible and ventrally folded in constricted state. Epigynum well scle-

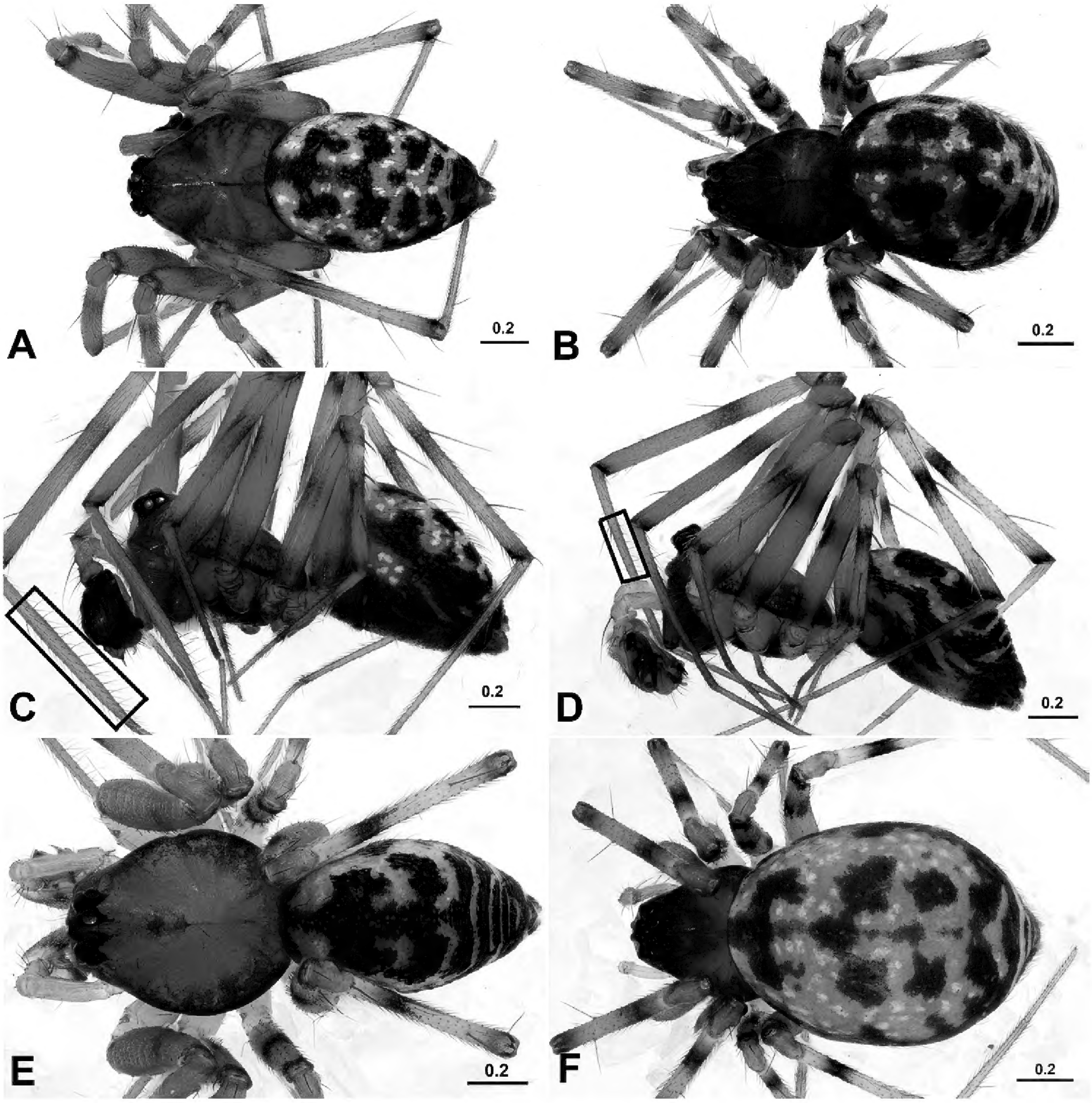

Figure 1. *Acanoides beijingensis* sp. n. (**A–C**) and *Acanoides hengshanensis* (**D–F**). **A** male, dorsal **B** female, dorsal **C** male, lateral, rectangle indicates ventrolateral rows of bristles on Mt I **D** male, lateral, rectangle indicates ventrolateral rows of bristles on Mt I **E** male, dorsal **F** female, dorsal. [Scale bars: mm].

rotized, epigynal cavity present (in *A. beijingensis* sp. n.) or absent (in *A. hengshanensis*), both scape and stretcher absent.

Etymology. The genus name, *Acanoides*, is a combination of the first four letters of "*Acanthoneta*" and the last five letters of "Wubanoides". "-oides" itself in Latin means "similar to", masculine in gender.

Phylogenetics. Due to limitations of the current dataset the monophyly of *Acanoides* could not be tested explicitly in our phylogenetic analyses, however it is supported by the following four putative synapomorphies: sharp embolus proper, slender and unbranched lamella characteristica, outside radix located Fickert's gland and ventrally folded extensible epigynal basal part.

Distribution. China (Beijing, Hunan, Hebei) (Fig. 7).

Remarks. The males of *Acanoides* gen. n. have the palp of a "micronetine" type: presence of the Fickert's gland, the boat-shaped radix, the trunk-like embolus with a pointed proper and a thumb, as well as the well developed terminal apophysis and lamella characteristica (Saaristo and Tanasevitch 1996). However, these sclerites in *Acanoides* (Fig. 2D) have some features different from the normal "micronetine" type (Fig. 6F, Saaristo and Tanasevitch 1996): Fickert's gland is not embedded within the radix, but located in the membranous area connecting the radix and the embolus; and the embolus has a wide, strongly sclerotized body, with a longer and sharper embolus proper, whereas in most "micronetines" the embolus is usually trunk-like with a pointed embolus proper. The male palp of both *Acanoides* and *Acanthoneta*, have a long and slender lamella characteristica parallel to the long radix, but with an additional long and thin branch in *Acanthoneta* (Fig. 6F), unbranched in *Acanoides* (Figs 2D, 3D). The epigynum of *Acanthoneta* is in a normal "micronetine" type, with a sigmoid scape surrounded by an epigynal cavity (Fig. 6H), but with an extensible basal part in *Acanoides*.

The result of phylogenetic analysis based on molecular data indicates that Ipainae is not a monophyletic group as the movable epigynum independently evolved in *Acanoides* and *Solenysa* (Appendix - Fig. S1). This is also supported by the tracheal characters: haplotracheate type in *Acanoides*, but intermediate type in *Solenysa*, with the median pair extending into the prosoma (Tu and Hormiga 2011). We infer that the extensible basal part of the epigynum may have also evolved convergently with that in other ipaines. In *Acanoides* it differs by being ventrally folded, while it forms a solenoid in *Solenysa* (Tu & Hormiga, 2011), and folds inwards in other ipaines, e.g *Ipa* (Saaristo 2007: fig. 29), *Wubanoides* and *Epibellowia* (Tanasevitch 1996: figs 7–9). Furthermore, the male palp of typical ipaines has filiform embolus proper (Saaristo 2007: fig. 7; Tanasevitch 1996: figs 1, 4) much longer than that of *Acanoides* (Fig. 2D).

Acanoides beijingensis sp. n.

http://zoobank.org/CE596A12-9C21-4B8F-97FC-F31CBC61CD7E
http://species-id.net/wiki/Acanoides_beijingensis
Figs 1A–C, 2, 4

Type-locality. China, Beijing: Mt. Yangtaishan, 39°20.15'N; 115°34.52'E, alt. ca 320m, 15 Oct. 2007, L. Tu leg.

Type-specimens. Holotype, ♂ (CNU), China, Beijing, Mt. Yangtaishan, 39°20.15'N; 115°34.52'E, alt. ca 320 m, 15 Oct. 2007, L. Tu leg. Paratypes, 2 ♂♂ and 3 ♀♀ (CNU), same data as holotype.

Additional material examined. 1 ♂ and 2 ♀♀ (CNU), China, Hebei Province, Mt. Wulingshan, 40°33.61'N; 117°29.69'E, alt. ca 1100 m, 12 Aug. 2009, L. Tu leg.

Diagnosis. The male of *A. beijingensis* sp. n. can be distinguished from *A. hengshanensis* by the spine-shaped lamella characteristica (Figs 2D, 4C), ribbon-like in the latter (Figs 3D, 5C); by the hook-shaped terminal apophysis (Fig. 4C), straight in the latter (Fig. 5D); and by the presence of a distal suprategular apophysis (Fig. 4A), absent in

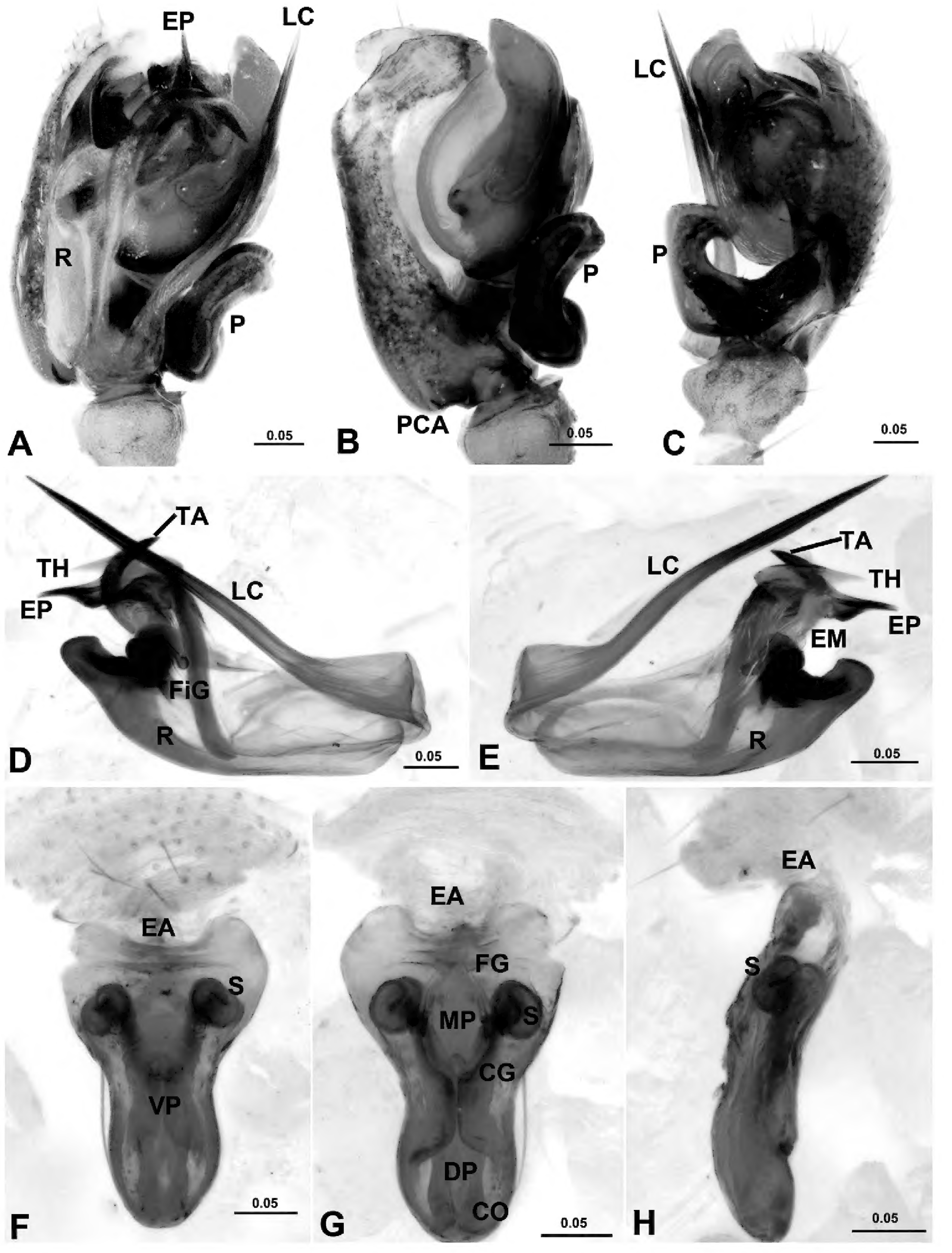

Figure 2. *Acanoides beijingensis* sp. n. **A** male palp, prolateral **B** male palp, prolateral, with embolic division removed **C** male palp, retrolateral **D** embolic division, ventral **E** embolic division, dorsal **F** epigynum, ventral **G** epigynum, dorsal **H** epigynum, lateral. CG copulatory groove; CO copulatory opening; DP dorsal plate; EA extensible area of epigynal basal part; EM embolic membrane; EP embolus proper; FG fertilization groove; FiG Fickert's gland; LC lamella characteristica; MP median plate; P paracymbium; PCA proximal cymbial apophysis; R radix; S spermathecae; TA terminal apophysis; TH thumb of embolus; VP ventral plate. [Scale bars: mm].

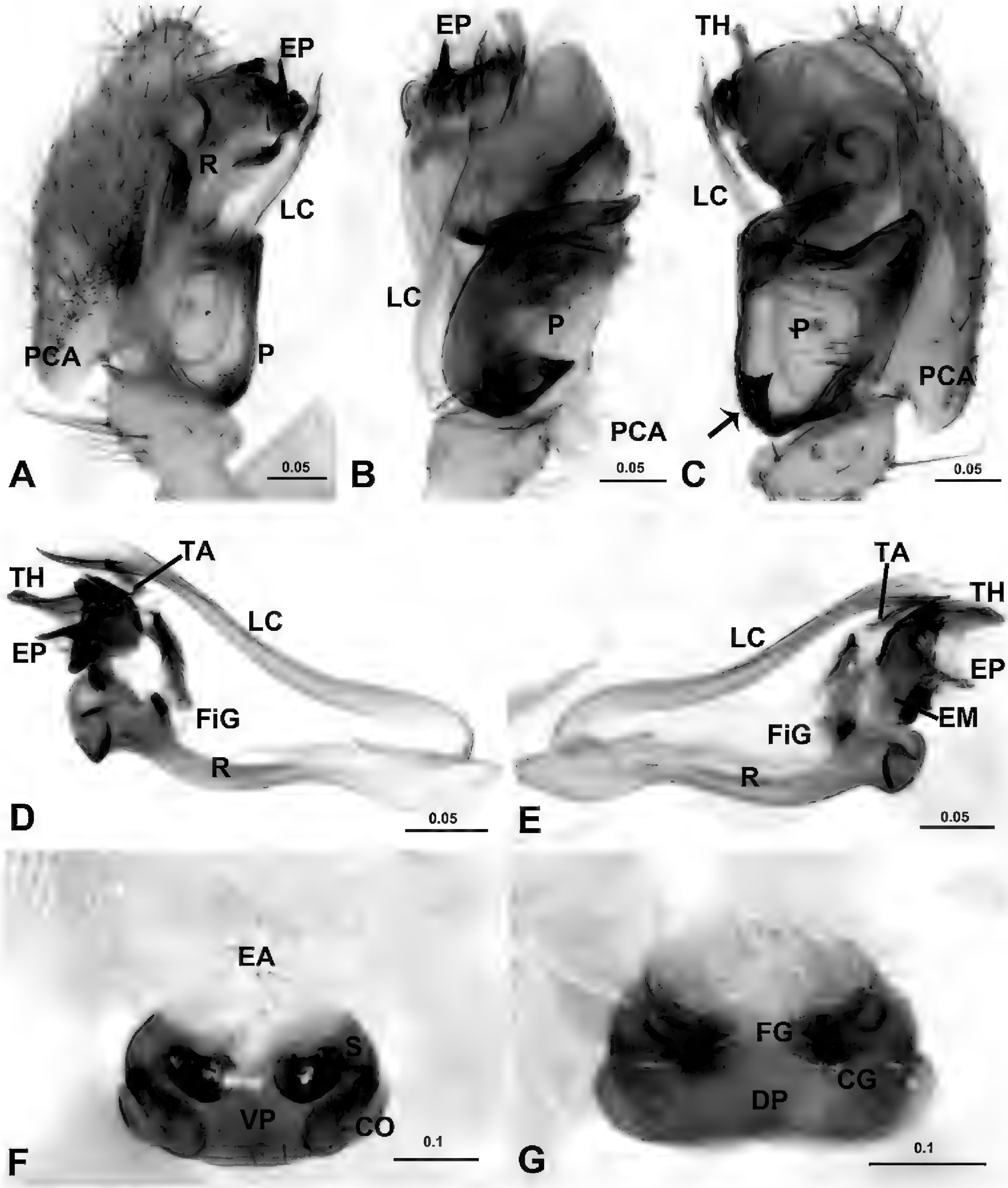

Figure 3. *Acanoides hengshanensis.* **A** male palp, prolateral **B** male palp, ventral **C** male palp, retrolateral, arrow indicates pointed tooth on posterolateral margin **D** embolic division, ventral **E** embolic division, dorsal **F** epigynum, ventral **G** epigynum, dorsal. CG copulatory groove; CO copulatory opening; DP dorsal plate; EA extensible area of epigynal basal part; EM embolic membrane; EP embolus proper; FG fertilization groove; FiG Fickert's gland; LC lamella characteristica; P paracymbium; PCA proximal cymbial apophysis; R radix; S spermatheca; TA terminal apophysis; TH thumb of embolus; VP ventral plate. [Scale bars: mm].

the latter. The female is distinct by having the epigynum two times longer than wide (Fig. 2F), shorter than wide in *A. hengshanensis* (Fig. 3F); and by the presence of a remnant epigynal cavity (Fig. 2G), totally absent in *A. hengshanensis* (Fig. 3G).

Description. Male holotype (Fig. 1A, C): Total length 2.69. Carapace 1.22 long, 1.01 wide. Abdomen 1.39 long, 0.88 wide. Lengths of legs: I 3.88 (1.05 + 1.18 + 0.99 + 0.66); II 3.02 (1.03 + 0.73 + 0.69 + 0.57); III 2.66 (0.87 + 0.88 + 0.51 + 0.40); IV 3.78 (1.12 + 1.09 + 0.93 + 0.64). Female (Fig. 1B): Total length 2.12. Carapace 0.93 long, 0.78 wide. Abdomen 1.25 long, 0.83 wide. Lengths of legs: I 6.10 (1.68 + 2.04 + 1.43 + 0.95); II 5.43 (1.56 + 1.74 + 1.24 + 0.89); III 4.39 (1.24 + 1.13 + 1.10 + 0.75); IV 5.88 (1.79 + 1.78 + 1.46 + 0.83). Tm I: 0.20. For other somatic features see description of the genus.

Male palp (Figs 2A–C, 4A–B). Cymbium with proximal apophysis. Paracymbium narrow, half rounded lateral tooth strongly sclerotized. Distal suprategular apophysis blunt, not modified as pit hook. Embolic division: radix long and narrow; Fickert's gland located in the membranous area connecting radix and embolus; embolus main body short and wide, strongly sclerotized, with serrated area on ventral surface; embolus proper sharp with pointed thumb and tail-like apex at each side; unbranched lamella characteristica long and slender, with sharp and strongly sclerotized apex; terminal apophysis hook-shaped with distal membrane.

Epigynum (Figs 2F–H, 4G–H). Two times longer than wide, wrinkled basal part extensible and ventrally folded in constricted state. Median plate and epigynal cavity present, without scape and stretcher. Copulatory openings opened dorsally.

Etymology. The species name refers to the type locality.

Variation. *Males* (n = 3). Total length 2.61–2.73. Carapace: 1.13–1.27 long, 0.95–1.05 wide. Abdomen 1.34–1.45 long, 0.71–0.99 wide.

Females (n = 3). Total length 2.10–2.23. Carapace: 0.90–0.96 long, 0.74–0.78 wide. Abdomen: 1.10–1.38 long, 0.79–0.88 wide.

Distribution. China (Beijing, Hebei) (Fig. 7).

Remarks. Although *A. beijingensis* sp. n. looks quite different from *A. hengshanensis* in the shape of the male paracymbium and in terms of female epigynal morphology, the strongly sclerotized embolus main body and the sharp embolus proper, the location of Fickert's gland, the presence of a ventrally folded extensive area of the epigynal basal part and the absence of a scape and stretcher, shared by the two species suggest they are closely related. A close relationship between the two species is additionally supported by the phylogenetic analysis (Appendix - Fig. S1).

Acanoides hengshanensis (Chen & Yin, 2000), comb. n.

http://species-id.net/wiki/Acanoides_hengshanensis
Figs 1D–F, 3, 5

Lepthyphantes hengshanensis Chen & Yin, 2000: 87, figs 12–16 (♂)
Acanthoneta hengshanensis: Tu et al. 2006: 412, figs 24–27 (♂).

Type-specimen. Holotype of *L. hengshanensis* Chen & Yin, 2000, ♂ (HNU), China, Hunan Province, Mt. Hengshan, 27°18'N; 112°42'E, 1–7 Aug. 1995, C. Yin leg. (examined).

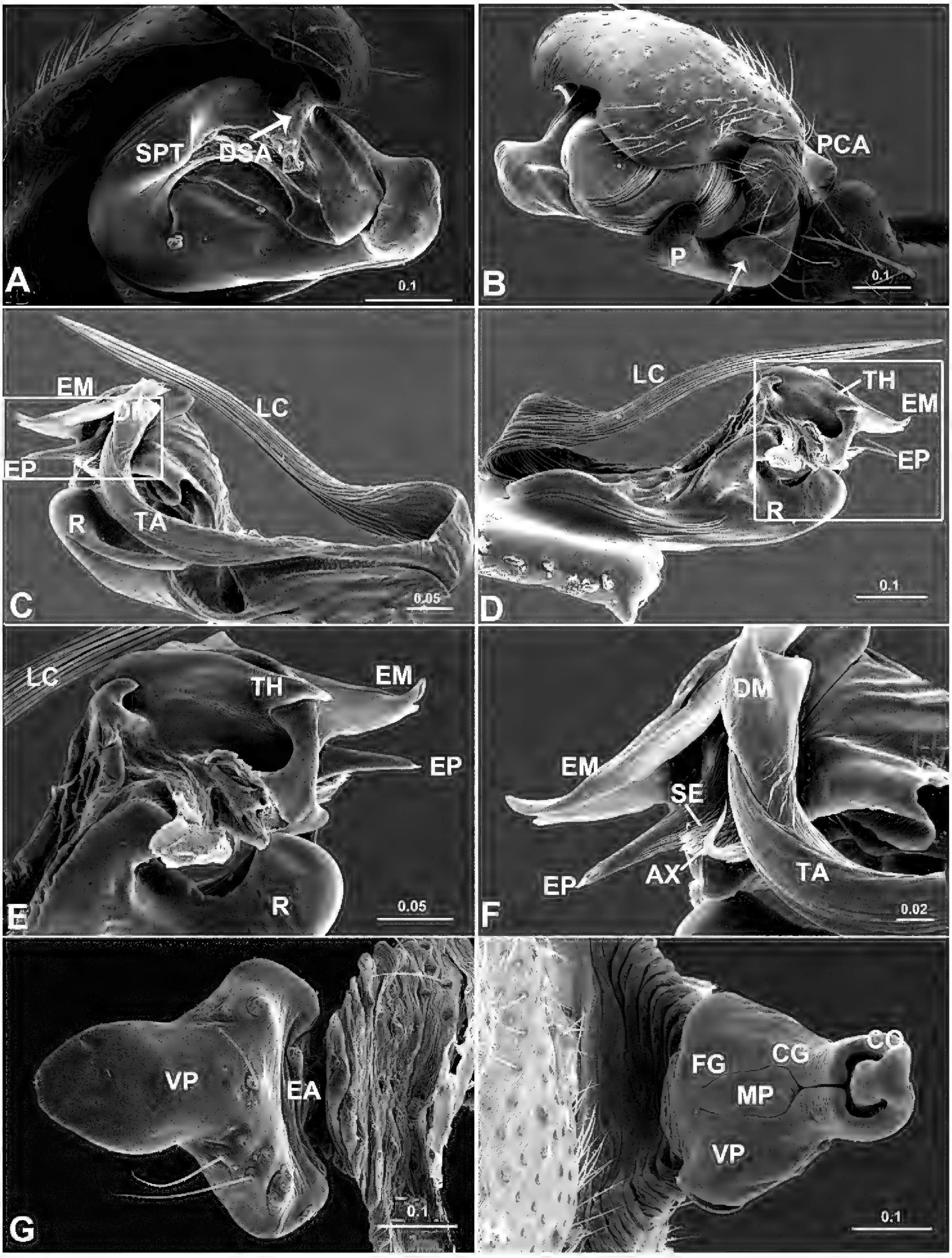

Figure 4. *Acanoides beijingensis* sp. n. **A** palp (embolic division removed), prolateral **B** palp, retrolateral, arrow indicates half rounded lateral tooth on paracymbium **C** embolic division, ventral **D** embolic division, dorsal **E** detail of D **F** detail of C **G** epigynum, ventral **H** epigynum, dorsal. AX apex of embolus; CG copulatory groove; CO copulatory opening; DM distal membrane of terminal apophysis; DSA distal suprategular apophysis; EA extensible area of epigynal basal part; EM embolic membrane; EP embolus proper; FG fertilization groove; LC lamella characteristica; MP median plate; P paracymbium; PCA proximal cymbial apophysis; R radix; S spermatheca; SE serrated area on embolus; SPT suprategulum; TA terminal apophysis; TH thumb of embolus; VP ventral plate. [Scale bars: mm].

Additional material examined. 3 ♂♂ and 4 ♀♀, China, Beijing, Mt. Yangtaishan, Dajue Temple, 40°03.06'N; 116°05.97'E, alt. 50 m, 15 Oct. 2007, L. Tu leg.

Diagnosis. See diagnosis for *A. beijingensis* sp. n.

Description. Male (Fig. 1D–E): Total length 2.39. Carapace 1.02 long, 0.78 wide. Abdomen 1.37 long, 0.78 wide. Lengths of legs: I 5.03 (1.37 + 1.56 + 1.32 + 0.78), II 3.33 (0.98 + 0.98 + 0.83 + 0.54), III 3.47 (0.98 + 1.07 + 0.88 + 0.54), IV 4.63 (1.27 + 1.41 + 1.22 + 0.73). Tm I: 0.24. Female (Fig. 1F): Total length 2.42. Carapace 0.96 long, 0.78 wide. Abdomen 1.80 long, 1.25 wide. Lengths of legs: I 4.21 (1.18+ 1.42 + 0.96 + 0.65), II 3.19 (0.98 + 1.06 + 0.66 + 0.49), III 2.81 (0.84 + 0.85 + 0.68 + 0.44), IV 3.70 (1.08 + 1.19 + 0.89 + 0.54). Tm I: 0.23. For other somatic characters see description of the genus.

Male palp (Figs 3A–C; 5A–B). Cymbium with distinct proximal apophysis pointing backwards. Paracymbium wide and U-shaped, with triangular tooth on posterolateral margin. Distal suprategular apophysis absent. Embolic division: radix long and narrow; Fickert's gland located in the membranous area connecting radix and embolus; embolus main body large and strongly sclerotized with serrated area; embolus proper sharp with large thumb and pointed apex; lamella characteristica long and slender with bifurcated ends, one sharp and sclerotized, one membranous; terminal apophysis straight, with distal membrane.

Epigynum (Figs 3F–G, 5G–H). Short and wide, box-shaped, strongly sclerotized; wrinkled basal part extensible and ventrally folded in constricted state. Neither median plate nor epigynal cavity present. Copulatory openings located on ventral surface, slits of epigynal grooves extending laterally, passing from ventral to dorsal surface, then convergent mesally. No scape, no stretcher.

Variation. *Males* (n = 3). Total length 2.34–2.41. Carapace: 1.09–1.12 long, 0.72–0.93 wide. Abdomen 1.14–1.42 long, 0.68–0.83 wide.

Females (n = 4). Total length 2.32–2.42. Carapace: 0.87–1.01 long, 0.75–0.81 wide. Abdomen: 1.63–1.82 long, 0.76–1.22 wide.

Distribution. China (Beijing, Hunan) (Fig. 7).

Genus *Acanthoneta* Eskov & Marusik, 1992 stat. n.

Acanthoneta Eskov & Marusik, 1992: 34. Described as a subgenus of *Poeciloneta*.
Acanthoneta: Saaristo and Tanasevitch 1996: 175. Raised to generic status without any comments or argumentation.

Type species. *Poeciloneta aggressus* (Chamberlin & Ivie, 1943).

Composition. Three species: *A. aggressa* Chamberlin & Ivie, 1943 (Nearctic), *A. dokutchaevi* Eskov & Marusik, 1993 (Far East Asia) and *A. furcata* Emerton, 1913 (Nearctic).

Comments. Originally *Acanthoneta* was described as a subgenus of *Poeciloneta*, including two species: *Poeciloneta* (*A.*) *aggressa* and *Poeciloneta* (*A.*) *furcata*. One ad-

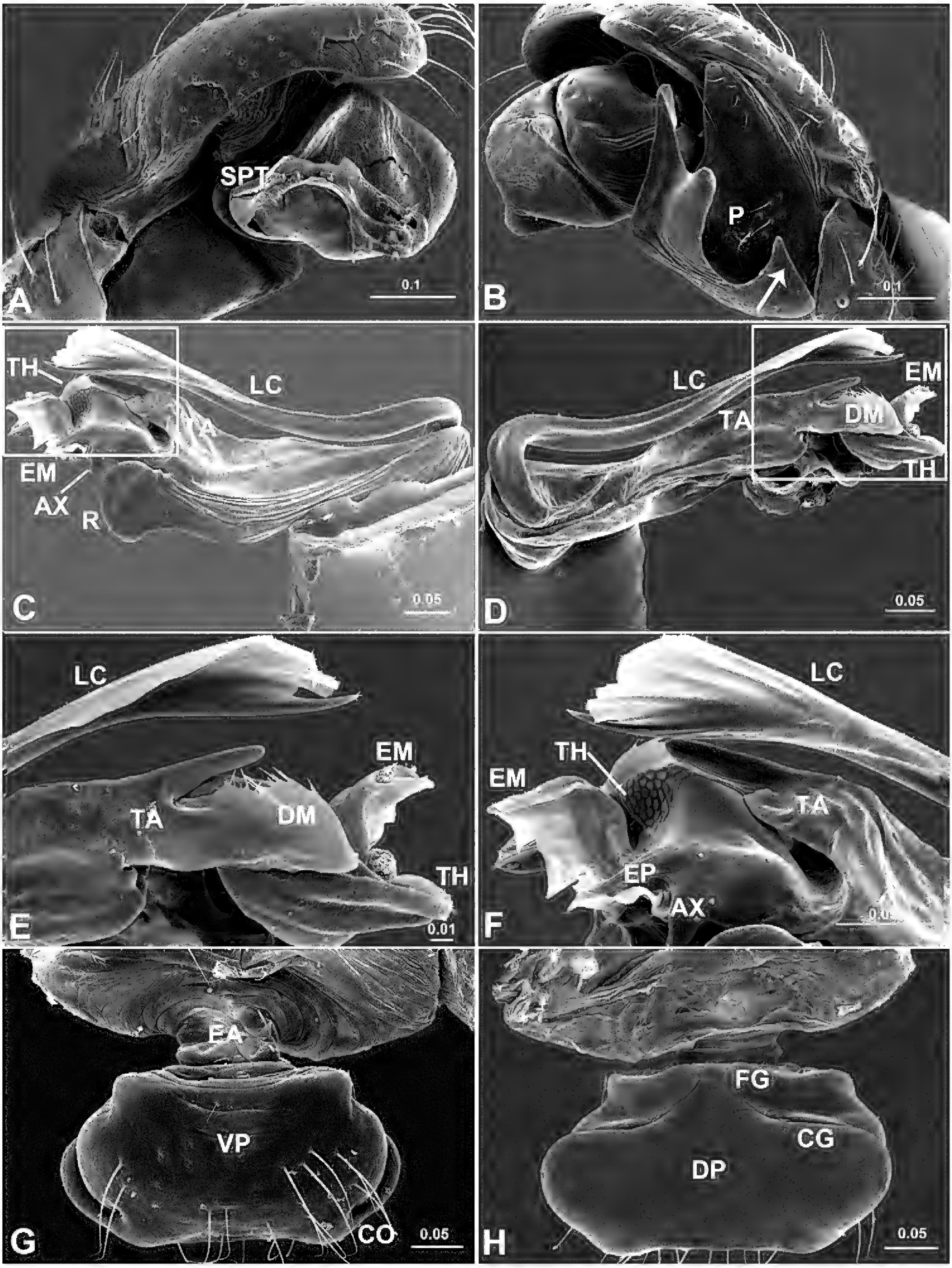

Figure 5. *Acanoides hengshanensis.* **A** palp (embolic division removed), prolateral **B** palp, retrolateral, arrow indicates pointed tooth on posterolateral margin **C** embolic division, ventral **D** embolic division, dorsal **E** detail of D **F** detail of C **G** epigynum, ventral **H** epigynum, dorsal. AX apex of embolus; CG copulatory groove; CO copulatory opening; DM distal membrane of terminal apophysis; EA extensible area of epigynal basal part; EM embolic membrane; EP embolus proper; FG fertilization groove; LC lamella characteristica; P paracymbium; PCA proximal cymbial apophysis; R radix; S spermatheca; SPT suprategulum; TA terminal apophysis; TH thumb of embolus; VP ventral plate. [Scale bars: mm].

ditional species *A. dokutchaevi* was assigned to the subgenus by Eskov and Marusik (1993). Saaristo and Tanasevitch (1996) raised *Acanthoneta* to genus status without any argumentations and hence the new status was not accepted by Platnick (2014). Here we provide a diagnosis for *Acanthoneta* and a comparison with *Poeciloneta*.

Diagnosis. Males of *Acanthoneta* differ from *Poeciloneta* by the long radix almost parallel with the long lamella characteristica (Fig. 6F), in the latter the radix is normal boat-shaped, lamella characteristica large and ribbon-like (Saaristo and Tanasevitch 2000: fig. 11). Females of the two genera differ by the epigynum in *Acanthoneta* having a sigmoid scape surrounded by an epigynal cavity, the lateral wall of which is posteriorly extended (Fig. 6H), whereas in *Poeciloneta* the scape is exposed, enlarged and strongly sclerotized (Saaristo and Tanasevitch 2000: fig. 18).

Acanthoneta aggressa (Chamberlin & Ivie, 1943)

http://species-id.net/wiki/Acanthoneta_aggressa
Fig. 6H–J

Lepthyphantes aggressus Chamberlin & Ivie, 1943: 14, figs 19–20.
Poeciloneta aggressa: Crawford 1988: 19.
Acanthoneta aggressa: Saaristo and Tanasevitch 1996: 175.
Poeciloneta aggressa: Paquin and Dupérré 2003: 147, figs 1623–1625.

Material examined. No material examined, epigynum pictures were provided by Don Buckle (Saskatoon, Canada): 1 ♀, Canada, Alberta, Chinook Lake, under log in spruce or fir woods, 49°40'N; 114°30'W, 25 Jul. 1988, D. J. Buckle leg.

Description. *Epigynum* (Fig. 6H–J). Slightly protruding, without extensible area at basal part. Epigynal cavity, with posteriorly extended lateral wall, surrounding sigmoid folded scape; scape long and narrow, with well developed lateral lobes hosting copulatory openings and distal stretcher.

Distribution. Across North America from Washington State to Québec (Buckle et al. 2001; Paquin and Dupérré 2003).

Acanthoneta dokutchaevi Eskov & Marusik, 1993

http://species-id.net/wiki/Acanthoneta_dokutchaevi
Fig. 6A–G

Poeciloneta (*Acanthoneta*) *aggressa* non Chamberlin & Ivie, 1943: Eskov and Marusik 1992: 34–35, figs 11–13 (♂).
Poeciloneta (*Acanthoneta*) *dokutchaevi*: Eskov and Marusik 1993: 52, figs 49–51 (♂).

Material examined. 1 ♂, China, Jilin Province, Mt. Changbaishan, Ski. 42°01.54'N; 128°04.25'E, alt. ca 1260 m, 31 July 1971.

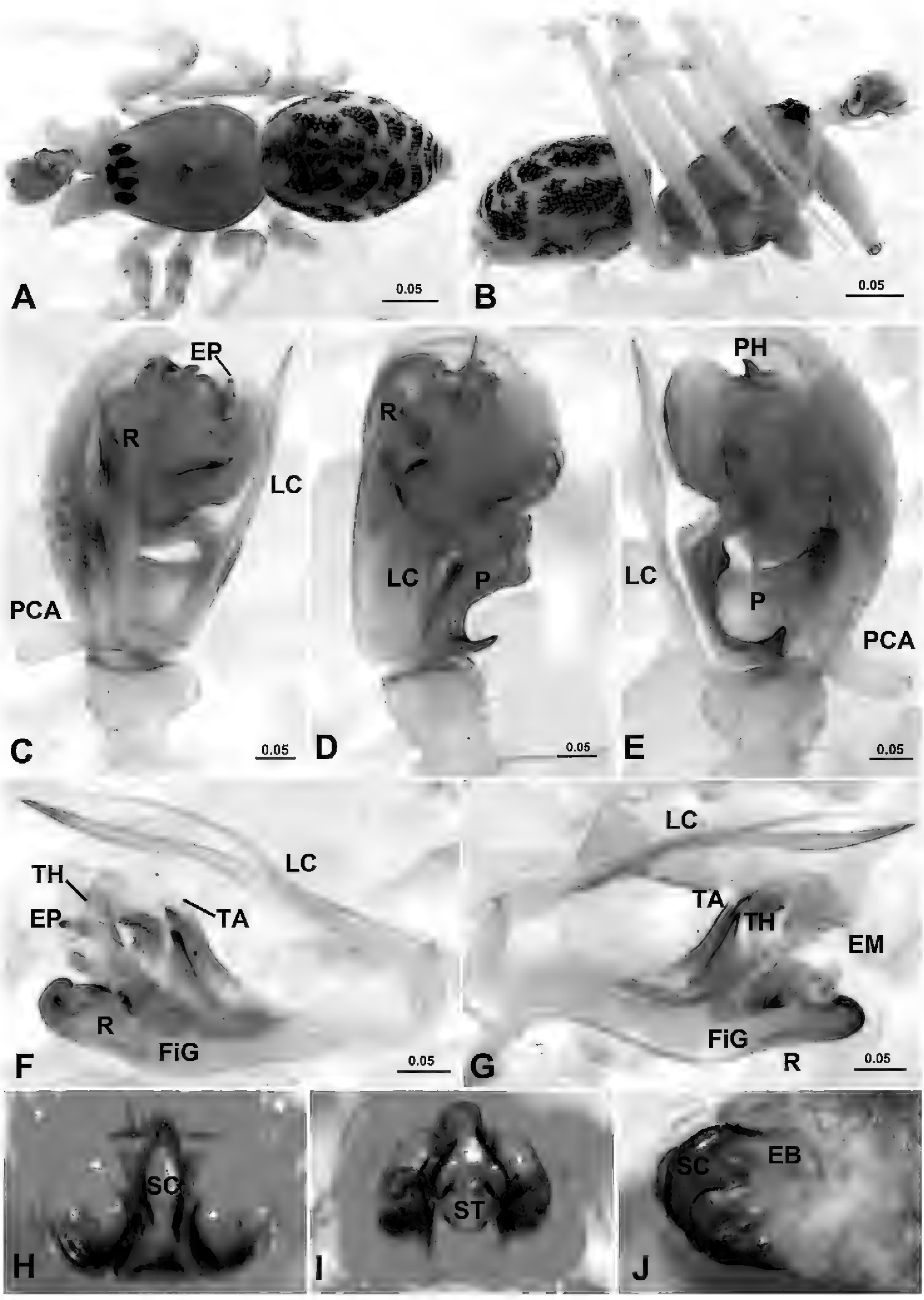

Figure 6. *Acanthoneta dokutchaevi* (**A–G**) and *Acanthoneta aggressa* (**H–J**). **A** male, dorsal **B** male, lateral **C** male palp, prolateral **D** male palp, ventral **E** male palp, retrolateral **F** embolic division, ventral **G** embolic division, dorsal **H** epigynum, ventral **I** epigynum, posterior **J** epigynum, lateral (**H–J** photos provided by Don Buckle). EB epigynal basal part; EM embolic membrane; EP embolus proper; FiG Fickert's gland; LC lamella characteristica; P paracymbium; PCA proximal cymbial apophysis; PH pit hook; R radix; SC scape; ST stretcher; TA terminal apophysis; TH thumb of embolus. [Scale bars: mm].

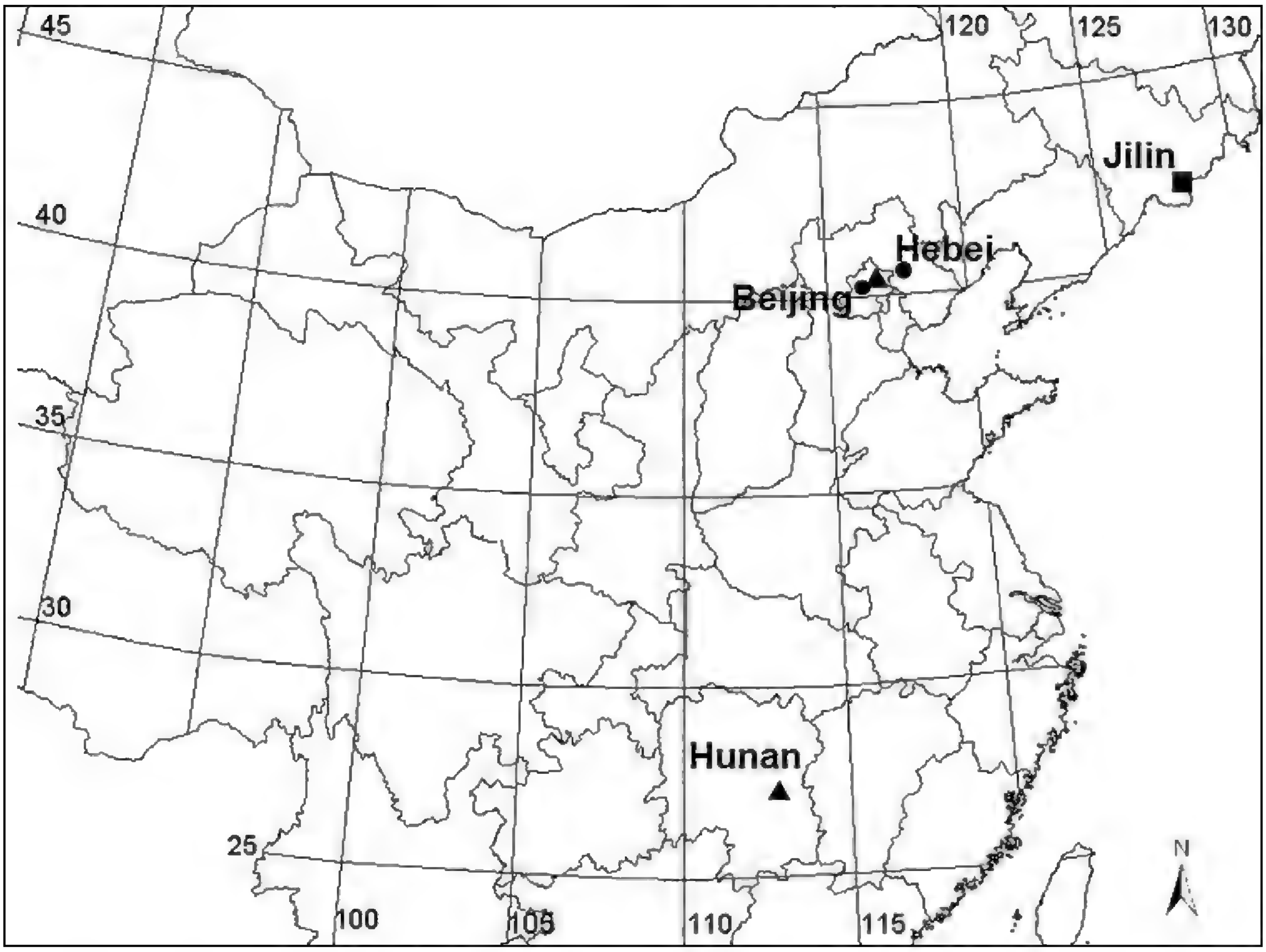

Figure 7. Collecting localities of *Acanoides* species and *Acanthoneta aggressa*, *Acanoides beijingensis* sp. n. (Beijing, Hebei); *Acanoides hengshanensis* (Hunan, Beijing); *Acanthoneta dokutchaevi* (Jilin).

Description. Male (Fig. 6A–B). Chelicera long, with strong stridulatory ridges. Chaetotaxy: Ti I–IV: 2-2-2-2; Mt I–IV: 1-0-0-1; Tm I about 0.80, Tm IV present. For other somatic characters see description by Eskov and Marusik (1993).

Male palp (Fig. 6C–E). Cymbium with proximal apophysis erected. Paracymbium wide, with two pointed teeth on lateral margin. Distal suprategular apophysis modified as pit hook. Embolic division: radix long and narrow; Fickert's gland located within radix; embolus main body trunk-like with serrated area, pointed embolus proper and well developed thumb; lamella characteristica fork-like branched, long and slender, almost parallel to radix; terminal apophysis with distal membrane and two strongly sclerotized teeth on ventral side.

Female. Unknown.

Remarks. The male of this species is similar to the type species *A. aggressa*. It differs only by the shape of the paracymbium. For a detailed comparison see Eskov and Marusik (1993).

Distribution. Far East Asia: Magadan Area (Eskov and Marusik 1993) and China (Fig. 7) (new record).

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Appendix

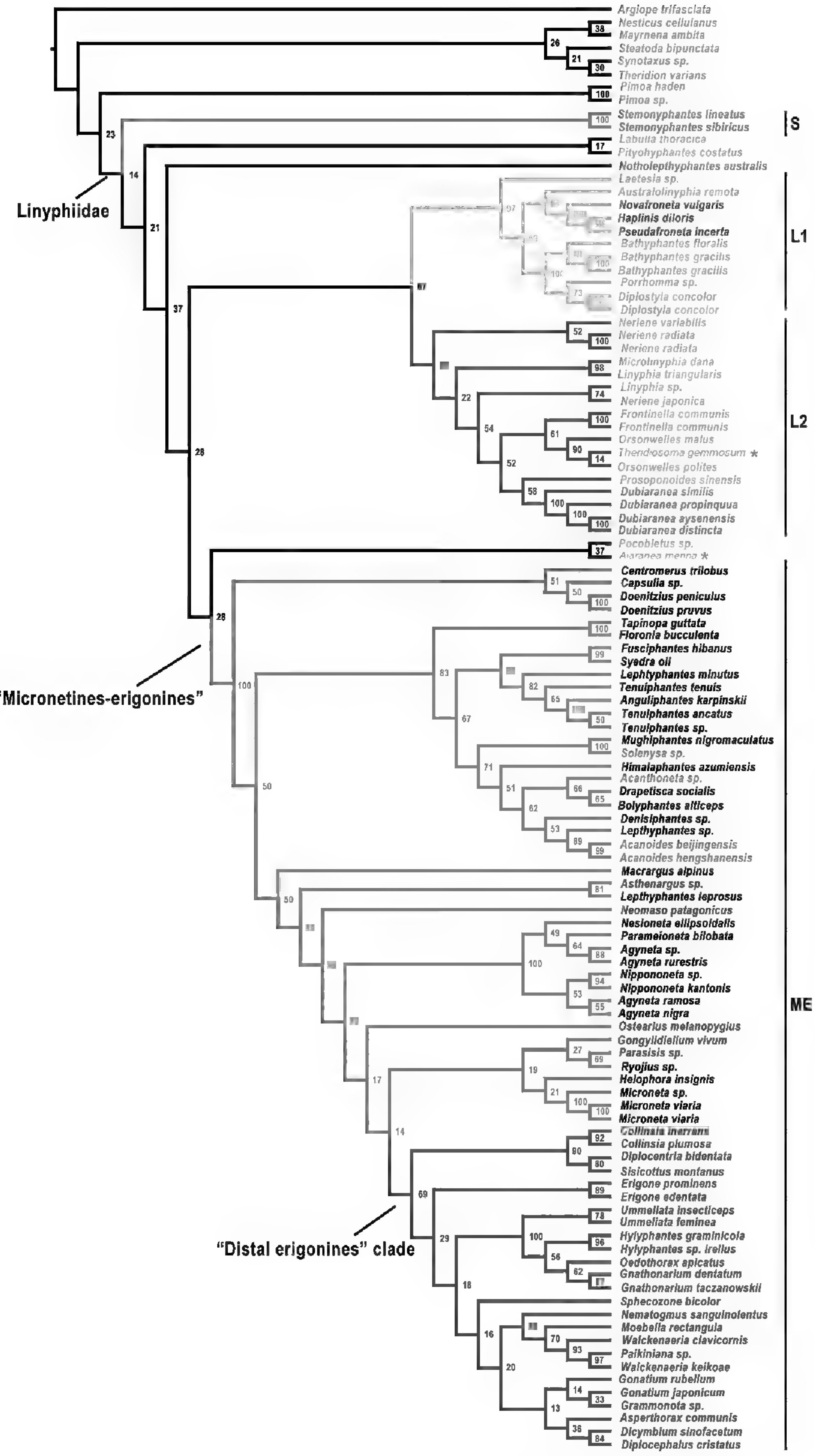

Figure S1. Linyphiid phylogeny resulting from Maximum Likelihood analysis based on molecular data. Numbers at the nodes are bootstrap value. Branches in color indicate the four robustly supported clades within linyphiids: **S** *Stemonyphantes* clade (blue) **L1** "linyphiines"-1 clade (pale green) **L2** "linyphiines-2" clade (dark blue) **ME** "micronetines-erigonines" clade (red, with "Distal erigonines" clade in green). Taxa in different colors sampled from different groups: grey, outgroup; blue, Stemonyphantinae; pale green, Linyphiinae; dark blue, Mynogleninae; pink, Dubiaraneinae; black, Micronetinae; red, Ipainae, *Acanthoneta* and *Acanoides* gen. n.; green, Erigoninae. Red stars indicate the two out-group taxa: cyatholipid *Alaranea* and theridiosomatid *Theridiosoma* embedded within Linyphiidae.

Table S1. GenBank accession numbers. Data of the taxa labeled with "#" are newly sequenced; the taxa labeled with "*" come from Arnedo et al. 2009.

Family	Genus	Species	16s	18s	28s	COI	H3
Araneidae	*Argiope*	*trifasciata*		FJ525386	FJ525368	FJ525316	FJ525335
Cyatholipidae	*Alaranea*	*merina**	AY230942	AY230890	AY231074	AY231022	AY230982
Mysmenidae	*Maymena*	*ambita*	GU456746	GU456765	GU456824	GU456876	GU456921
Nesticidae	*Nesticus*	*cellulanus*	EU746444	AF005447	AF124961	EU746435	
Pimoidae	*Pimoa*	*haden*	GU338640	GU338524	EF128112	EF128155	
Pimoidae	*Pimoa*	sp.*	AY230940	AY230893	AY231072	AY231025	AY230985
Synotaxidae	*Synotaxus*	sp.	AY230943	AY230894	AY231076	AY231026	AY230986
Theridiidae	*Steatoda*	*bipunctata**	AY230951	AY230926	AY231084	AY231057	AY231014
Theridiidae	*Theridion*	*varians**	AY230976	AY230932	AY231111	AY231063	AY231017
Theridiosomatidae	*Theridiosoma*	*gemmosum*	HM030408	HM030417	HM030428	HM030436	HM030443
Linyphiidae	*Acanoides*	*beijingensis*#	KJ027589	KJ027587	KJ027580	KJ027582	KJ027583
	Acanoides	*hengshanensis*#	KJ027585	KJ027588	KJ027584	KJ027586	KJ027581
	Acanthoneta	sp.		GU338479	GU338560	GU338678	
	Agyneta	sp.	GU338621		GU338529		
	Agyneta	*ramosa**	FJ838670	FJ838694	FJ838717	FJ838648	FJ838740
	Anguliphantes	*karpinskii*		GU338516	GU338566	GU338680	
	Asperthorax	*communis*		GU338482	GU338545	GU338684	
	Asthenargus	sp.		GU338493	GU338561		
	Australolinyphia	*remota**	FJ838671	FJ838695	FJ838718	FJ838649	FJ838741
	Bathyphantes	*floralis*	GU338604	GU338465	GU338583	GU338659	
	Bathyphantes	*gracilis**	FJ838672	FJ838696	FJ838719	FJ838650	FJ838742
	Bathyphantes	*gracilis*	GU338630	GU338464	GU338582	GU338689	
	Bolyphantes	*alticeps**	AY078660	AY078667	AY078678	AY078691	AY078700
	Capsulia	sp.		GU338470	GU338586		
	Centromerus	*trilobus*	GU338599	GU338468	GU338571	GU338656	
	Collinsia	*inerrans*	GU338601	GU338518		GU338645	
	Collinsia	*plumose*	GU338638	GU338499	GU338543		
	Denisiphantes	sp.	GU338619	GU338508	GU338563	GU338669	
	Dicymbium	*sinofacetum*	GU338614	GU338487	EF128119	GU338665	

Family	Genus	Species	16s	18s	28s	COI	H3
	Diplocentria	*bidentata*	GU338629	GU338494	GU338542	GU338688	
	Diplocephalus	*cristatus*	GU338637	GU338490		GU338696	
	Diplostyla	*concolor**	FJ838673	FJ838697	FJ838720	FJ838651	FJ838743
	Diplostyla	*concolor*	GU338639	GU338467	GU338585	GU338697	
	Doenitzius	*peniculus*	GU338631	GU338469		GU338690	
	Doenitzius	*pruvus*	GU338632	GU338474		GU338691	
	Drapetisca	*socialis**	FJ838674	FJ838698	FJ838721	FJ838652	FJ838744
	Dubiaranea	*aysenensis*	FJ838675	FJ838699	FJ838722	FJ838653	FJ838745
	Dubiaranea	*distincta*	GU338624	GU338459	GU338579	GU338648	
	Dubiaranea	*propinquua*	GU338627	GU338460	GU338580	GU338675	
	Dubiaranea	*similis*		GU338521	GU338581	GU338681	
	Erigone	*edentate*		GU338486	GU338540	GU338686	
	Erigone	*prominens*		GU338498	GU338539	GU338679	
	Floronia	*bucculenta**	FJ838676	FJ838700	FJ838723	FJ838654	FJ838746
	Frontinella	*communis*	GU338628	GU338517	GU338573		
	Frontinella	*communis**	FJ838677	FJ838701	FJ838724	FJ838655	FJ838747
	Fusciphantes	*hibanus*		GU338512	GU338570	GU338683	
	Gnathonarium	*dentatum*	GU338593	GU338477	EF128120	GU338651	
	Gnathonarium	*taczanowskii*	GU338620	GU338480	GU338547	GU338670	
	Gonatium	*japonicum*	GU338613	GU338492			
	Gonatium	*rubellum**	FJ838679	FJ838703	FJ838726	FJ838656	FJ838749
	Gongylidiellum	*vivum**	FJ838678	FJ838702	FJ838725		FJ838748
	Grammonota	sp.		GU338491		GU338685	
	Haplinis	*diloris**	FJ838680	FJ838704	FJ838727	FJ838657	FJ838750
	Helophora	*insignis**	FJ838681	FJ838705	FJ838728	FJ838658	FJ838751
	Himalaphantes	*azumiensis*		GU338522	GU338564	GU338677	
	Hylyphantes	*graminicola*	GU338595	GU338478	GU338550	GU338653	
	Hylyphantes	sp.	GU338618	GU338481	GU338549	GU338668	
	Labulla	*thoracica**	AY078662	AY078674	AY078680	AY078694	AY078707
	Laetesia	sp.*	FJ838682	FJ838706	FJ838729	FJ838659	FJ838752
	Lepthyphantes	*minutus**	AY078663	AY078673	AY078681	AY078689	AY078705

Family	Genus	Species	16s	18s	28s	COI	H3
	Lepthyphantes	*leprosus*		GU338488	GU338565	GU338682	
	Lepthyphantes	sp.	GU338610	GU338509	GU338562	GU338664	
	Linyphia	*triangularis**	AY078664	AY078668	AY078682	AY078693	AY078702
	Linyphia	sp.	GU338597	GU338461	GU338572	GU338654	
	Macrargus	*alpinus*		GU338505	GU338559		
	Agyneta	*nigra*	GU338608	GU338504	GU338577	GU338662	
	Agyneta	*rurestris**	FJ838683	FJ838707	FJ838730	FJ838660	FJ838753
	Microlinyphia	*dana**	AY078665	AY078677	AY078683	AY078690	
	Microneta	sp.	GU338609	GU338472	GU338538	GU338663	
	Microneta	*viaria**	FJ838684	FJ838708	FJ838731	FJ838661	FJ838754
	Microneta	*viaria*	GU338598	GU338502	GU338537	GU338655	
	Moebelia	*rectangular*	GU338591	GU338485	GU338557		
	Mughiphantes	*nigromaculatus*	GU338600	GU338510	GU338527	GU338644	
	Nematogmus	*sanguinolentus*	GU338635	GU338489	GU338544	GU338694	
	Neomaso	*patagonicus*	GU338626	GU338473	GU338578	GU338674	
	Neriene	*japonica*	GU338633	GU338462	GU338575	GU338692	
	Neriene	*radiata**	AY078710	AY078670	AY078684	AY078696	AY078709
	Neriene	*radiate*	GU338623	GU338463	GU338574	GU338672	
	Neriene	*variabilis**	AY078711	AY078669	AY078685	AY078699	AY078706
	Nesioneta	*ellipsoidalis*		GU338519	GU338532	GU338687	
	Nippononeta	*kantonis*	GU338634	GU338471	GU338530	GU338693	
	Nippononeta	sp.	GU338602	GU338520	GU338531	GU338657	
	Notholepthyphantes	*australis**	FJ838685	FJ838709	FJ838732	FJ838662	FJ838755
	Novafroneta	*vulgaris**	FJ838686	FJ838710	FJ838733	FJ838663	FJ838756
	Oedothorax	*apicatus**	FJ838687	FJ838711		FJ838664	FJ838757
	*Orsonwelles**	*malus*	AY078737	AY078676	AY078795	AY078697	AY078708
	*Orsonwelles**	*polites*	AY078725	AY078671	AY078786	AY078755	AY078701
	Ostearius	*melanopygius**	FJ838688	FJ838712	FJ838735		FJ838758
	Paikiniana	sp.	GU338617	GU338495	GU338555	GU338647	
	Parameioneta	*bilobata*	GU338605	GU338503	GU338533	GU338660	
	Parasisis	sp.	GU338592	GU338500	GU338534	GU338650	

Family	Genus	Species	16s	18s	28s	COI	H3
	Pityohyphantes	*costatus**	AY078666	AY078675		AY078695	
	Pocobletus	sp.*	FJ838689	FJ838713	FJ838736	FJ838665	FJ838759
	Porrhomma	sp.	GU338607	GU338466	GU338584	GU338661	
	Prosoponoides	*sinensis*	GU338606		GU338576	GU338649	
	Pseudafroneta	*incerta**	FJ838690	FJ838714	FJ838737	FJ838666	FJ838760
	Ryojius	sp.	GU338611		GU338536		
	Sisicottus	*montanus*	GU338625	GU338497	GU338541	GU338673	
	Solenysa	sp.	GU338616	GU338506	GU338528	GU338667	
	Sphecozone	*bicolor*	GU338622	GU338496	GU338553	GU338671	
	Stemonyphantes	*lineatus**	FJ838691	FJ838715	FJ838738	FJ838667	FJ838761
	Stemonyphantes	*sibiricus**	FJ838692			FJ838668	FJ838762
	Syedra	*oii*	GU338615	GU338513	GU338569	GU338666	
	Tapinopa	*guttata*		GU338511	GU338558	GU338676	
	Tenuiphantes	*ancatus*		GU338515	GU338567		
	Tenuiphantes	sp.	GU338612	GU338514	GU338568	GU338646	
	Tenuiphantes	*tenuis**	FJ838693	FJ838716	FJ838739	FJ838669	FJ838763
	Ummeliata	*feminea*	GU338594	GU338475	GU338551	GU338652	
	Ummeliata	*insecticeps*		GU338476	GU338552		
	Walckenaeria	*clavicornis*	GU338596	GU338483	GU338554		
	Walckenaeria	*keikoae*	GU338636	GU338484	GU338556	GU338695	